Integrating Wind Resources into the NW Power System

Discussion Paper presented at the TBL Business Practices Forum

by Lon Peters, Consultant, and Rod Noteboom, Grant County PUD

1. Wind resources have unique characteristics that require generation integration services from TBL or another control area. These characteristics place demands on the control area that are different from other generation resources.

2. Wind resources require the following services:
   - Capacity needs to be set aside to cover uncertainty in forecasts of wind generation, similar to the uncertainty that governs load forecasts, which, in the TBL control area, pay a Load Variance charge.
   - Wind resources require regulation services to cover second-to-second variations in output. Wind resources are not capable of providing this service.
   - Wind resources require operating reserves, both for complete failure of the unit and for complete failure of the fuel supply.
   - Wind resources require generation imbalance, to cover differences between hourly scheduled amounts and actual output.
   - Transmission of wind generation requires scheduling, system control, and dispatch, just like the transmission of other resources.
   - Similarly, transmission of wind resources can lead to voltage control requirements and should pay reactive charges.

3. Arguments that wind resources place minimal demands on the control area, if applied generally, would create incentives for other generation resources to cause costs that would be paid by all control area customers. It is unreasonable for BPA's customers to be asked to pay for "hidden" subsidies through special treatment of any resources.

4. Wind generation resources should face the usual charges paid for the transmission of other resources on the TBL system, and should pay for standby capacity services required to meet the unique characteristics of wind power.

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Introduction

Wind should pay for the costs they put on the system. BPA's customers should not be required, through TBL policies, to subsidize generation being developed by other parties. Wind is a unique resource, in that it causes costs similar to those caused by other generators, in addition to those caused by variable loads. Thus, wind resources should pay the same costs faced by other resources who seek or require similar services from the control area, but should also pay the same costs faced by customers who have variable loads that require similar generation services. There are several types of costs that wind resources cause due to their intermittent nature. These costs should be recovered from wind developers, or the appropriate transmission contract holders, rather than BPA's ratepayers generally.

The computer model used by wind generators to schedule wind output has no bearing on the incremental costs of supplying shaping services, except to eliminate any opportunity to arbitrage market prices. An independent or unbiased schedule of wind output will not eliminate all the other costs associated with services required to integrate wind resources. BPA should recognize that federal resources provide shaping services to wind generation, and these resources have costs, either embedded or opportunity.

Furthermore, BPA's power cost surcharges (CRACs) are having a substantial negative effect on the Northwest consumers and the regional economy, and this is not the time to expand implicit or hidden subsidies to anyone. If there is a valid reason to subsidize wind or any other resource, it should be done explicitly. Under the circumstances, it is highly unlikely that BPA has the financial resources to provide such explicit subsidies.

Appropriate Charges for Integration of Wind Resources

This paper discusses the types of charges that wind producers, or the transmission contract holders for wind generation, should expect to pay if they are going to pay for services in the same manner as PF customers with variable loads and developers of similar resources.

1. *Capacity.* BPA must set aside a certain amount of generation capacity to be available to provide shaping (hour-to-hour) services for variable loads that are not subject to "control" of some kind. Accordingly, BPA-PBL charges such PF customers Load Variance (LV) service, which is based on the concept of "readiness-to-serve", which in turn reflects the fact that LV service is an "option". (See §2.3.4. of the 2002 Final Power Rate Proposal, May 2000.) BPA priced LV service in 2000 based on the cost of put and call options using the Black-Scholes option pricing model. The LV charge has increased with BPA's LB-CRAC and FB-CRAC, and will increase with any SN-CRAC. Purchasers of BPA's Load Variance service pay an option premium (the LV charge), which permits the customer to "strike" at the PF rate (either putting energy to BPA or calling on additional energy from BPA). Because of the nature of wind resources, a similar charge would seem to be appropriate for the shaping services required for wind generation as well. Thus, similar calculations should be performed

for wind resources. Even though wind resources may "strike" imbalance energy at the market price, they do not do so on an hourly basis, and thus the deadband creates an option to strike at the <u>average</u> market price in the month.

- Some may argue that generation imbalance service covers the uncertain costs of integrating a variable resource such as wind. However, it is appropriate for wind resources to pay a separate capacity charge in addition to generation imbalance. Other generators in the TBL control area pay for regulation (which is based on the capacity set aside for regulation) and generation imbalance. However, wind resources cause greater uncertainty in the hour-to-hour ramp rates, and thus impose costs that are different from other generation resources, which justifies an additional charge similar to Load Variance. For example, TBL normally starts ramping generation ten minutes before the hour and concludes ten minutes after the hour, based on the <u>scheduled</u> amounts of generation and transmission and the forecasted amounts of load. The fact that the load forecasts are imprecise justifies, at least in part, the LV charge. Actual wind generation looks more like a "load forecast error" than a "generation schedule error", because of the similarity in the inability to forecast loads and wind output precisely. Thus, a separate capacity charge for wind, based on the concept of Load Variance, is appropriate.

2. <u>*Regulation.*</u> Wind generation, like load and most other generation, can vary on a second-to-second basis, as well as within and between hours. Such variation on a second-to-second basis places a demand for generation regulation on the system. Wind developers should pay for generation regulation at the posted TBL rate for this service. Wind generation benefits from the fact that other generation capacity, normally hydro, has been set aside for the purpose of providing regulation services.

3. *Operating Reserves.* Wind generation, like other generation, can go off line during an hour, and the control area operator will normally carry the schedule for (at least) the remainder of the hour. ~~Wind, unlike most other resources, requires operating reserves both for the complete failure of the unit as well as complete absence of fuel supply.~~ Thus, wind generation should pay for spinning and supplemental reserves at the posted TBL rates for this service.

4. *Generation Imbalance.* Deviations of actual energy transmitted from scheduled energy for an hour are charged imbalance energy, which is also supplied by the control area. Wind generation should face the same charges as other TBL customers for this service. Again, this is not the same as the capacity charge discussed above, because imbalance captures the differences between scheduled and actual generation integrated over the schedule hour.

5. *Scheduling, System Control and Dispatch.* Wind generators should pay these charges, just like other TBL customers. The systems that are in place for this service apply equally to wind resources and other uses of the transmission system.

6. *Reactive Supply and Voltage Control.* Wind generators should pay these charges, just like other TBL customers. Again, voltage support on the grid is required, notwithstanding the nature of the resource that is being used to supply loads.

Alternative Approaches to Establishing Charges for Wind Integration

Proponents of wind development have proposed other approaches to these issues. This section of the paper presents some of these arguments, and responses.

1. *A control area looks at its net requirement, not one based on the individual variations is either generation or load.*
   - Although this statement may be true, it does not yield any conclusion about who should pay for the costs of integration. If the marginal costs of integration are not adequately signaled to generators individually, then their behavior may easily shift costs to other customers of the control area, or even to the customers of other control areas depending on how inadvertent is cleared out.

2. *If a wind farm is scheduled to deliver 25 Mw at any instant, and it actually only delivers 20, the control area does not necessarily need to move some other generator up 5 Mw -- it would depend on the deviations of all other resources at that precise instant.*
   - This may be true as a matter of fact, but if we expand this logic to all generators and loads, then no generator or load would be charged for imbalance service, and those costs would be completely "socialized". This would provide an incentive for all generators and loads to arbitrage market prices across time, thus increasing the costs that are socialized. We must be careful to avoid sending the wrong price signals.

3. *Wind and load seem to move in completely uncorrelated ways. So, as many times as not, a wind deviation compensates appropriately for a generation/load imbalance.*
   - By extension, any generator should be permitted to deviate from schedule, as long as the generation deviations are not correlated with load deviations. This could impose significant costs on the control area, which would pass such costs along to its customers.

4. *The Eric Hirst study shows that -- at least on the BPA system – the current levels of wind create little, if any incremental financial costs. The regulation (generation that responds to second-to second variations in the load/resource balance) increased by less than two percent at current wind penetration levels. BPA has concluded that this is within the "noise" of the model methodology. Hirst suggests that as wind penetration increases, the cost may become more significant and measurable. He says "[t]he cost to integrate wind with the BPA power system, including adjustments for day-ahead forecast errors and real-time regulation and load following requirements, is likely to be well under $5/MWh of wind output for 1000 MW of wind capacity." Eric Hirst, "Integrating Wind Energy with the BPA Power System: Preliminary Study", prepared for BPA, September 2002, p. 35.*
   - Almost anything can be quantified in such a manner that it appears to be "small" relative to the size of the BPA system. Every MWH of load is "small" compared with the size of the system, but that does not mean that we should ignore the costs that are required to cover such load variations. The Hirst study is also useful because it provides a quantification of the error in BPA's day-ahead (DA) load forecasts (p. 17), which supports the need, in part, for a Load Variance-type charge for wind. The Hirst study also used actual data on wind generation to calculate proxy forecast errors for four wind farms on the BPA system with 164 MW of capacity: the result is forecast errors that are <u>much higher</u> than the forecast errors for BPA's DA load forecasts (pp. 20-21). This suggests additional justification for a LV-type charge for wind generation.

5. *The Cal-ISO authorized an optional settlement option that allows wind generators to carry their deviations across time (as BPA allows in Tier 1), and settle at the end of the month.*
   - The fact that the wind generators cannot control their deviations does not mean that those deviations are costless. (An individual homeowner cannot control the

> incidence of earthquakes, and yet if an earthquake happens to the individual homeowner, the impact will not be costless, and we normally expect homeowners to carry their own earthquake insurance.) Thus, the question should be, what charge is reasonable to permit the wind generators to carry deviations across time and settle at the end of the month? The deviation deadband may or may not impose costs on the control area operator, depending on whether the market value of the positive deviations perfectly offsets the market value of the negative deviations. The deadband is essentially an option to put or call at the average monthly market price, which is different from a right to put or call at the hourly market price. There is a risk that the settlement at the average monthly price will not cover the entire cost of providing the deviation service, so it would seem that an option premium would be appropriate. If all generators and loads are given the same deadband, then we have agreed collectively to socialize these option premiums. If wind generators are given a wider deadband, then we have collectively agreed to subsidize wind beyond the socialization of the costs in the normal deadband. If wind generators can demonstrate a social benefit associated with such socialized costs, then this may not be an objectionable result. However, we should be explicit about it, and not argue that the costs are "too small to measure".

<u>Further Discussion of the Hirst Study</u>

Even Hirst concluded that the "small" errors in wind forecasts are the result of the small size of the wind farms (p. 21). As additional wind generation is integrated into the regional power system, the size of the forecast errors will grow in absolute value, as will the costs of integrating wind (*ceteris paribus*). Furthermore, Hirst used what he called a "high price" of $5/MWH for "capacity required in real time that was not scheduled day ahead" (p. 35). This "high price" may in fact be an <u>underestimate</u> of the opportunity cost (not the embedded cost) of holding capacity off the market to cover the forecast errors in wind generation. Finally, Hirst concludes that because wind actual generation is sometimes above and sometimes below the DA forecast, "wind has almost no effect on BPA capacity requirements" (p. 35). If this were true, BPA would also have to set aside no capacity to meet load forecast errors, which are also "roughly symmetrical" (p. 17). However, BPA charges loads that are subject to load forecast error, and should therefore charge wind generation subject to forecast error in a similar manner.

<u>Conclusions</u>

It is appropriate to charge customers more than just the instantaneous marginal cost of providing the service. Most industries must have capacity standing ready to serve, and expect to recover those capacity costs in the prices that they charge. For example, because the fuel is effectively free, the instantaneous marginal cost of wind generation must be nearly zero. Surely wind generators would not expect to sell energy at a near-zero price, but must expect to recovery capacity costs in the prices they charge. Similarly, other businesses do not normally set prices at the marginal cost of the last unit sold, but try to ensure that they can cover <u>all</u> of their costs.